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GB 2157824 A EP 0711995 A2

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(54) Abstract Title
Container inspection machine

(57) A machine for inspecting walls of containers, such as bottles (10), delivered by conveyor (12) to an inspection station (16) has a light source (18), diffuser element (19) and a camera (14). The light source comprises a plurality of vertical rows of sources, such as LEDs, the rows performing a spatially cyclical continuously varying light intensity pattern. The pattern can consist of the output light intensity of a row being 100% (white), the intensity of a plurality of adjacent rows systematically decreasing to a lowest level where light blocking defects can be seen by the camera (14), then increasing systematically to the next white row. A computer (15) provided for analysing the camera image compares neighbouring pixels (one or more away) alone or in combination to determine the rate of change in intensity to identify defects where the rate of change exceeds a defined value.

FIG. 1

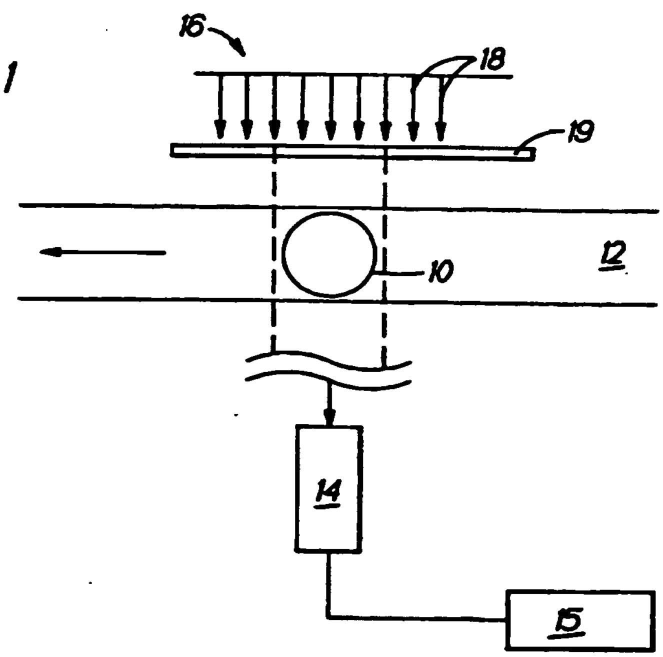

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FIG. 1

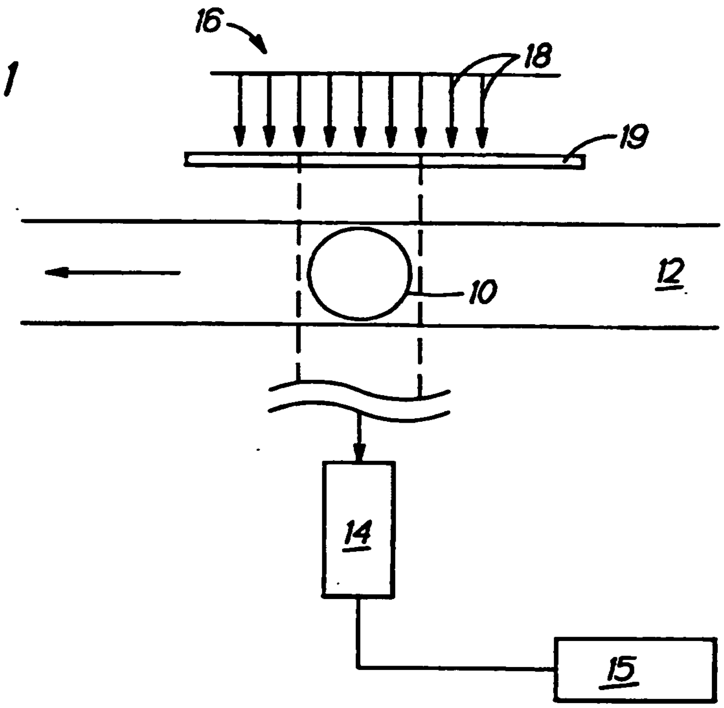

16
18
19
10
12
14
15

FIG. 3

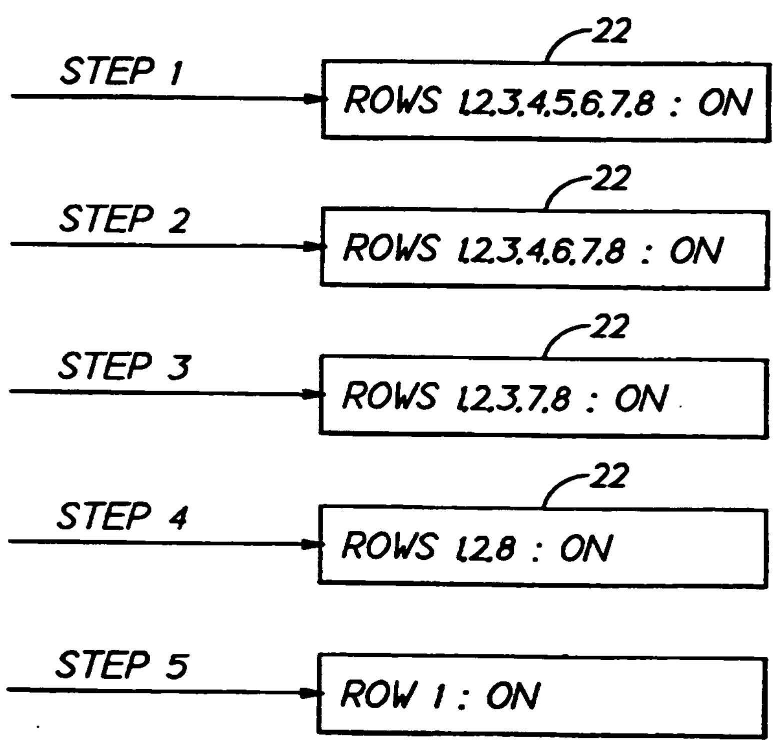
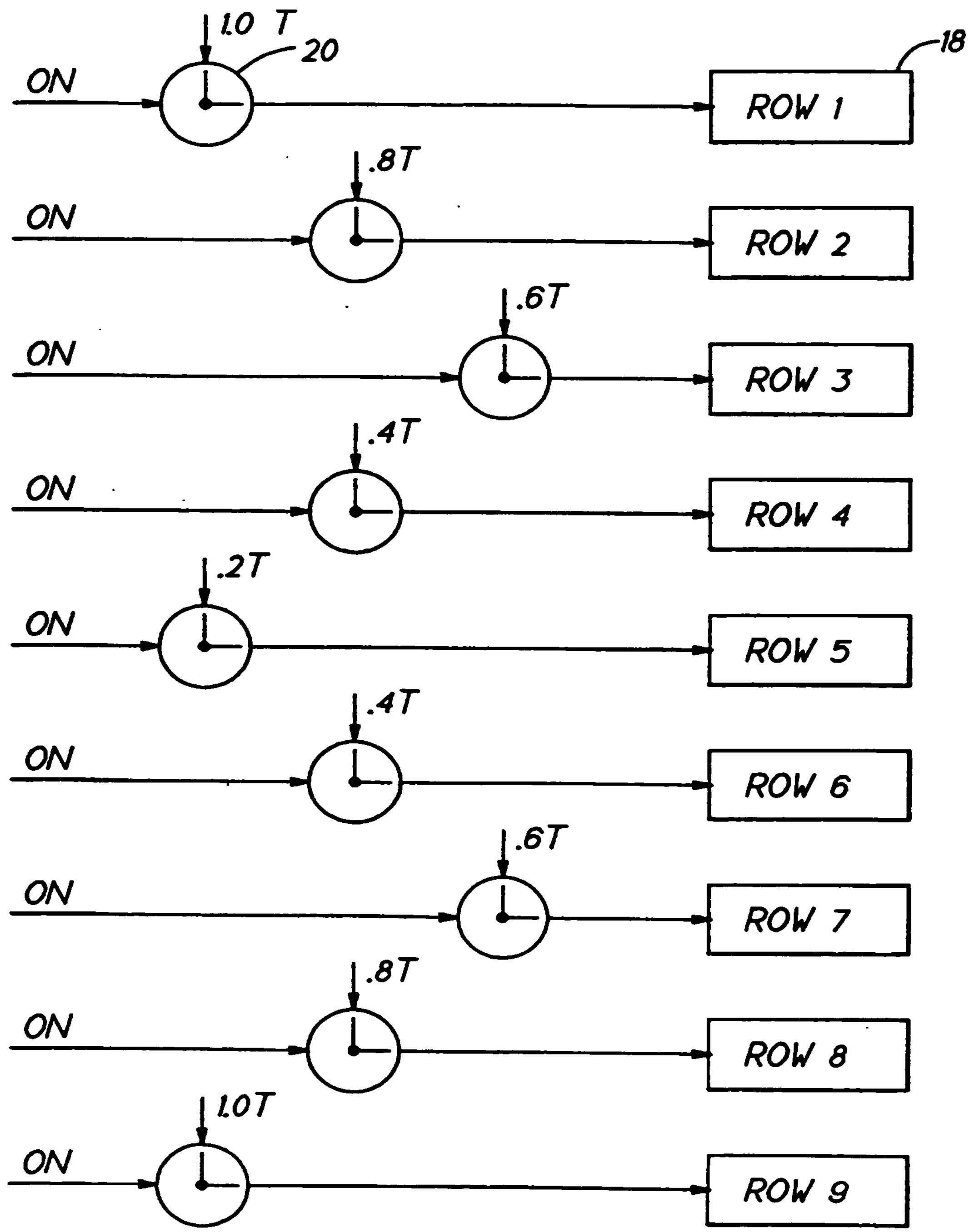

STEP 1
ROWS 1,2,3,4,5,6,7,8 : ON
22
STEP 2
ROWS 1,2,3,4,6,7,8 : ON
22
STEP 3
ROWS 1,2,3,7,8 : ON
22
STEP 4
ROWS 1,2,8 : ON
22
STEP 5
ROW 1 : ON

FIG. 2


1.0 T
20
18
ON
ROW 1
.8T
ON
ROW 2
.6T
ON
ROW 3
.4T
ON
ROW 4
.2T
ON
ROW 5
.4T
ON
ROW 6
.6T
ON
ROW 7
.8T
ON
ROW 8
1.0T
ON
ROW 9

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CONTAINER INSPECTION MACHINE

The present invention relates to a machine for inspecting glass or plastic containers such as bottles, and more particularly to such a machine which can inspect the sidewall of the container to find defects.

The side wall of a glass container can include various types of defects, including an area of unevenness in glass distribution which will provide a lensing effect when backlit (a refractive defect). Container inspection machines, such as shown in U.S. Patent No. 5,004,909, inspect the sidewall of a glass bottle by presenting the bottle in front of a light source defined by alternating black and white stripes. Such an inspection machine can find refractive defects best when they are located at the edge of the stripe. Container inspection machines, such as shown in U.S. Patent No. 4,601,395, inspect the sidewall of a glass container by presenting the bottle in front of a light source defined by a single bright area that is always in the view of the camera, with transversely spaced outer regions of various intensities, and rotating the container.

It is an object of the present invention to provide a container inspecting machine which will identify a light blocking defect when inspecting also for refractive defects.

The accompanying drawings illustrate a presently preferred embodiment incorporating the principles of the invention, in which:-

Figure 1 is a top view of a container inspection machine made in accordance with the teachings of the present invention;

Figure 2 is schematic representation showing the operation of the light source shown in Figure 1; and

Figure 3 is a schematic illustration showing the operation of the light source as implemented.

A transparent container such as a bottle 10, which can be either glass or plastic, is conveyed from right to left along a conveyor 12 for inspection at the illustrated inspection station where the bottle is imaged on

the image means of a CCD (charge-coupled device) camera 14, linear display camera, frame or interline transfer CCD, or the like. The image is evaluated to identify anomalous pixel readings which are indicative of a defect. Associated with the CCD camera is a controlled light source 16 which defines a large area of light. In the preferred embodiment there are a large number of vertical rows of L.E.D.s 18. As can be seen from Figure 1, the L. E. D. s are focused or aimed so that light will pass through the entire bottle (from top to bottom and from side to side) and be imaged on the camera. These vertical rows also are supported to emit light parallel to each other and the emitted light passes through a diffuser element 19. Each vertical row of L.E.D.s 18 is turned on and off with a field effect transistor or the like (not shown).

In Figure 2, an individual timer 20 is connected to each field effect transistor so that each row can be turned on for a selected time. The timers will time out at selected times (.2T,.4T,.6T,.8T, 1.0T) of an imaging cycle (here time is equated to the ideal time required for the row of L.E.D.s to appear illuminated to a selected degree) with light intensity being a function of the time on. For example, .60T is the time that a vertical row of lights must be on for the intensity of the row to appear 60%. For discussion purposes, the light of a fully on source is referred to as "white", but it should be understood that the light source may be colored and the illuminated light may in fact be invisible (an infrared L.E.D. for example). Actual "on" times may also be varied to compensate for overlapping illumination effects. Due to overlap of light output, actual "on" times, for a particular column, may need to be modified to achieve a best fit to the desired continuously varying intensity cycle. For example, the full bright (1.0T) columns, which may not get full white because they are getting only partial light from neighboring .8T columns, may need to be set at an increased time on (1. 15T, for example). Calculations based upon the actual performance of the illumination method, in this case, L.E.D./diffuser

combination, will determine the method of calculating corrections to produce the desired spatially cyclically continuously varying intensity between the extremes of dark and light intensity source.

As shown in Figure 3, a single control operates nine rows and defines bit masks 22 which turn on the desired vertical rows for each of each of the five repeated timed steps (as illustrated each step continues for .2T) of an imaging cycle. The image is defined over the period of these five steps. While these illustrations discuss the use of time to set the desired intensity level, current level could alternately be controlled for the same purpose. Other light sources can be used with various light output control over the area methods, such as LCD panel, or printed pattern, in conjunction with a shuttered camera for the same purpose. While there are five intensity levels (20%, 40%, 60%, 80% and 100%) in the illustrated embodiments, other numbers can be used. A spatially cyclically continuously varying intensity between the 20% bright and light is defined on the light source illumination area which cyclically changes at a rate of change which is less than that required to be detected as a defect. The minimum brightness level (20%) is chosen so that either a light blocking defect or a refractive defect can be identified by the CCD camera over 100% of the area of the light source.

As can be seen from Figure 3, full control over the individual column intensity goes beyond the fractional linearly calculated percentage previously presented. The pattern presented here could be described as a triangle wave whose peak is a full bright and valley is at 20% bright. As can be seen from Figure 3, full control over the number of columns going from 20% bright to bright can be exercised. Changing the number of columns can be done to optimize the cyclic nature of the pattern for a container size or defect size. The spatially varying intensity cycles may be horizontal or vertical or at some other angle. It may also be a combination of angles.

Full control over the relative position of the pattern to the overall backlight (and thus the container to be inspected) can also be controlled.

Where the inspection process may use dynamically located zones, the bright portion of the pattern can be optimally placed to aid in the location of the container.

For a one axis cyclic variation, a measure of the light source quality would provide a nearly flat histogram analysis of the source. A two axis light cyclic light source could also be used to generate such variations with individual LED control, using a transmissive light control scheme such as a light valve, LCD, or printed pattern. A computer 15 analyzes the camera image by comparing neighboring pixels (one or more away) alone or in combination to determine the rate of change in intensity to identify defects where the rate of change exceeds a defined value.

CLAIMS

1. A machine for inspecting the wall of a container comprising means for supporting a container at an inspection station, the inspection station including

a camera on one side of the support means, having camera image means,

a light source, having an illumination area, on the other side of the support means, for imaging the container on said camera image means,

means for defining a spatially cyclically continuously varying intensity between a minimum brightness level that will permit the identification of a light blocking defect therebehind and light on said light source illumination area at a rate of change which is less than that required to be detected as a defect, and

computer means for analyzing the camera image by comparing neighboring pixels (one or more away) alone or in combination to determine the rate of change in intensity to identify defects where the rate of change exceeds a defined value.

2. A machine for inspecting the wall of a container according to claim 1, wherein said support means is a conveyor, and said camera is a CCD camera.

3. A machine for inspecting the wall of a container according to claim 1 or 2, wherein said light source comprises a plurality of L.E.D. rows.

4. A machine for inspecting the wall of a container according to claim 3, wherein said plurality of L.E.D. rows define a plurality of row groups each including a light row at one side, a row having a minimum brightness, at least one row intermediate said white and minimum brightness rows having an intensity between minimum brightness and white, and at least one row

on the side of said minimum brightness row remote from said white row having an intensity between minimum brightness and white.

5. A machine for inspecting the profile and wall of a container according to claim 4, wherein there are a plurality of generally vertical L.E.D. rows intermediate the minimum brightness and white rows and the intensity of said plurality of intermediate rows uniformly reduces from the white row to the minimum brightness row.

6. A machine for inspecting the profile and wall of a container according to claim 5, wherein there are a plurality of generally vertical L.E.D. rows on the side of said minimum brightness row remote from said white row and the intensity of said plurality of said rows on the side of said minimum brightness row remote from said white row uniformly increase in intensity proceeding away from the minimum brightness row.

7. A machine for inspecting the profile and wall of a container according to claim 6, wherein said minimum brightness row has a brightness level of about 20% and wherein each of said generally vertical L.E.D. row groups has three generally vertical rows intermediate said minimum brightness and white rows, with the intensity of the row adjacent the minimum brightness row having an intensity of about 40% of the white row and the intensity of the row adjacent the white row having an intensity of about 80% of the white row and the intensity of the intermediate of the three generally vertical rows intermediate the minimum brightness row and white rows having an intensity of about 60% of the white row.

8. A machine for inspecting the profile and wall of a container according to claim 7, wherein each of said generally vertical L.E.D. row groups has three generally vertical rows on the side of said minimum brightness row

remote from said white row, with the intensity of the row adjacent the minimum brightness row having an intensity of about 40% of the white row and the intensity of the next row having an intensity of about 60% of the white row and the intensity of the last of the three vertical rows remote from the minimum brightness row having an intensity of about 80% of the white row.

9. A machine for inspecting the wall of a container, substantially as hereinbefore described with reference to the accompanying drawings.

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Application No:	GB 0011402.5	**Examiner:**	Iwan Thomas
Claims searched:	1-9	**Date of search:**	26 July 2000

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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): G1A AMAB; G1M MHAB; G1S SNX

Int Cl (Ed.7): G01N 21/89, 21/90

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2157824A	(OWENS-ILLINOIS) See page 2 lines 3-52	
A	EP 0711995A2	(EASTMAN KODAK) See col. 3 line 25-col. 4 line 23	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.